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Oscillatory Neurocomputers With Dynamic Connectivity

Provisional Patent Application for Letters Patent of the Inited States,
Serial No. 60/108,353.

Frank C. Hoppensteadt and Eugene M. Izhikevich

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Abstract. We suggest a novel design of neuro-computers using the following principles:

- Each neuron in the neuro-computer is a high-frequency oscillator.
- The oscillators have distinct frequencies.
- The oscillators are weakly connected by a common medium.
- The common medium is forced by an external **rhythmic input**.

When the input is constant or has inappropriate frequencies, the oscillators do not interact due to the same principle used in selective tuning in radio. However, the **rhythmic input** can force any two oscillators to interact, which we call dynamic connectivity, if the input's Power spectrum includes the frequency equal to the difference between the frequencies of the oscillators. Thus, the strength and arrangement of connections between the oscillators is not hard-wired, but it is dynamic and can be controlled by the **rhythmic input**.

There can be many realizations of such oscillatory neuro-computers since there are many mechanisms for producing these oscillatory behaviors. For example, the oscillators could be phase locked loops, VCOs (Voltage Controlled Oscillators), MEMS resonators, Josephson junctions, lasers, macromolecules, etc.

Detailed information is available.

Correspondence to Eugene Izhikevich

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Oscillatory Neurocomputers With Dynamic Connectivity

Physical Review Letters (1999), 82:2983-2986

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Abstract. Our study of thalamo-cortical systems suggests a new architecture for a neurocomputer that consists of oscillators having different frequencies and that are connected weakly via a common medium forced by an external input. Even though such oscillators are all interconnected homogeneously, the external input imposes a dynamic connectivity. We use Kuramoto's model to illustrate the idea and to prove that such a neurocomputer has oscillatory associative properties. Then we discuss a general case. The advantage of such a neurocomputer is that it can be built using voltage controlled oscillators (VCO), optical oscillators, lasers, micro-electromechanical systems (MEMS), Josephson junctions, macromolecules, or oscillators of other kinds. .

Full text in PDF file (393K),

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